## Remarks/Arguments

In the Office Action, dated January 12, 2005, the examiner confirmed the earlier restriction requirement and withdrawal of claims 1-3 from further consideration. The examiner also objected to the specification (Abstract). Therefore, the Abstract is amended as shown above, and the Abstract as amended is attached hereto on a separate sheet.

Claim 9 was rejected under 55 U.S.C. §112, second paragraph. Both of the items addressed by the examiner in this rejection have been remedied by this amendment.

Claims 8 and 9 were rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 10-29 of issued U.S. Patent No. 6,672,171. This obviousness-type double patenting rejection is obviated by the terminal disclaimer, which is part of this response.

Finally, claims 8 and 9 were rejected under 35 U.S.C. §103 as being unpatentable over the admitted prior art in the preamble of claim 1 in view of the S. Hanson et al. article "Pressure Measurement and Control in Loadlocks," Ikeda, Stocker et al. for claim 8 and in further view of Shie et al. for claim 9. Therefore, the applicant has amended claims 8 and 9 and added new claims 10-18 to more clearly recite the invention over the prior art references cited, as will be explained in more detail below.

The applicant believes the examiner is correct in focusing on the Hanson et al. article entitled "Pressure Measurement and Control in Loadlocks" published in Vacuum Technology (hereinafter "Hanson et al.") as the closest prior art to this invention. Hanson et al. were addressing the monitoring and control of load lock pump and vent sequences, but some of their solutions to problems encountered are different than the present invention, and

they did not foresee or suggest in their article the invention recited in the applicant's claims as now amended.

Essentially, Hanson et al. taught that three different pressure sensing devices were required to monitor and control the load lock pump and vent cycles, i.e., a convection enhanced pirani (CEP) gauge, a capacitance manometer switch referenced to vacuum, and another capacitance manometer switch referenced to atmosphere. Each of these three devices were used individually and mounted separately on the load lock by Hanson et al.

As explained by Hanson et al., page 154, first column, lines 9-15:

> "The convection-enhanced Pirani (CEP) is the type of gauge most commonly encountered on loadlocks . . . . Convection Pirani gauges are used on loadlocks for one simple reason: They are uncomplicated, relatively inexpensive, and can cover the entire pressure range associated with loadlocks. A typical CEP will measure from $10^{+3}$ to $10^{-3}$ torr."

Hanson et al. go on to explain the nature, characteristics, and operating elements and principles of a pirani sensor, concluding with the following at Hanson et al., page 154, first column, lines 31-41:

> "This mode of operation [molecular conduction] works most effectively from about 1 millitorr [$10^{-3}$ torr] to several torr, whereupon the heat transfer characteristic will flatten as condition becomes independent of pressure. As pressure increases further, convection currents will start to circulate around the [hot] wire. These convection currents also transport heat from the wire in a repeatable fashion.
>
> The exploitation of two distinct modes of operation, one [molecular conduction] associated with the medium vacuum regime and the other [convection currents] associated with viscous flow at high pressures, gives the CEP its extended range of operation."

Then Hanson et al. identify a weakness of convection-enhanced pirani [CEP] gauges, on page 154, second column, lines 1-9, as follows:

> "In the loadlock pumpdown, the critical parameters are the general pressure vs. time profile, proper crossover pressure to fast pumping, and reaching a satisfactory base pressure. The accuracy repeatability of the CEP are sufficient for the first and third items. The way the CEP operates, however, does lead to a couple of problems when this gauge is used for control applications where some level of precision is required, especially during the transition from soft pumping."

The applicant agrees with Hanson et al. that the convection-enhanced pirani [CEP] gauge is deficient for second item identified above by Hanson et al., i.e., proper crossover to fast pumping. However, the applicant does not agree with the assertion by Hanson et al. that the CEP gauge having a low-end accuracy of $10^{-3}$ torr is sufficient for the third item, i.e., reaching a satisfactory base pressure, at least in some applications, as will be discussed in more detail below.

Hanson et al. continue their explanation of the problems with CEP gauges for the second item on page 154, second column, lines 10-22, as follows:

> "In the region between about 10 and 100 torr, the [CEP] sensor is passing between the molecular conduction and convection modes and loses sensitivity. . . .
>
> Also, if the pressure is changing while the [CEP] gauge is in convection mode, a forced convection component is introduced as gas either moves into or out of the volume of the [CEP] gauge. This additional component will increase cooling of the wire, causing the gauge to indicate a higher pressure than the actual pressure. Therefore, if the Pirani is used to control the crossover to fast pumping, the gauge is in the area of its lowest accuracy and repeatability. Consequences include crossing over too soon --- turbulence/adiabatic cooling issues --- or too late --- lost cycle time. . . .

This crossover pressure of about 10 torr or slightly higher is critical, as explained by Hanson et al. on page 152, first column line 39, through page 152, second column, lines 1-5, as follows:

> "The cycle for the loadlock begins with the soft-pump (A) to avoid the above-noted problems of condensation and turbulence. A common way of achieving soft pumping is by use of a low conductance bypass line in parallel with the main isolation valve. . . . Fast pumping (B) commences at the point where condensation and turbulence will not have a strong effect, usually about 10 torr or slightly higher. At the crossover pressure (10 torr), any particles in the chamber cannot be transported by 'floating,' as occurs with dust at higher pressures."

Therefore, Hanson et al. teach that convection-enhanced pirani [CEP] gauges have an inherent inaccuracy in the region between about 10 and 100 torr and are insufficient for the critical load lock crossover pressure range of about 10 torr or slightly higher. Significantly, unlike the present invention, Hanson et al. suggest that the solution to this problem is to add another gauge to control the crossover from soft or slow pumpdown to fast pumpdown. As explained by Hanson et al., page 156, first column, lines 7-10:

> "The solution to these problems is to add a gauge that has a high level of accuracy and repeatability at the crossover point. Absolute pressure switches based on capacitance manometer technology meet these requirements."

Hanson et al. then explain how a capacitance monometer works for measuring absolute pressure and that it has an accuracy of 0.5% of full scale in the critical load lock crossover at 10 torr. See Hanson et al., page 156, first paragraph, lines 10-25.

Next, Hanson et al. also describe the use of a third gauge or switch, i.e., an atmosphere-referenced capacitance manometer based switch referenced to measure

differential pressure for opening the load lock door at 0 torr differential. See Hanson et al., page 156, second column.

Finally, Hanson et al. assert on page 156, second column, lines 30-32:

> "Figure 1 shows the types of gauges that are necessary for proper monitoring and control of the loadlock cycle."

In their Figure 1 on page 151, Hanson et al. show their three gauges or switches, each mounted individually on a load lock, including: (1) The convection-enhanced pirani gauge with its range of 1000 torr to $10^{-3}$ torr and its inherent inaccuracy in the 10-100 torr region where the load lock crossover pressure occurs; (2) The vacuum-referenced, capacitance manometer crossover switch with its accurate absolute pressure measuring capability at the load lock crossover pressure region; and (3) The atmosphere-referenced, capacitance manometer atmosphere [different pressure] switch for opening the load lock door at atmospheric pressure.

The present invention, on the other hand, provides a different solution that is neither taught nor fairly suggested by Hanson et al. or by any of the other prior art references. Again, the applicants do not claim to have invented the pirani gauge. They did, however, recognize that, with the use of an accurate differential pressure gauge to open the exterior door at atmospheric pressure, as taught by Hanson et al., a high-end absolute pressure sensing accuracy was no longer necessary in load lock applications, because the high-end pressure-time profile could be monitored sufficiently with the differential pressure gauge. Therefore, the inventors recognized that a pirani gauge for such load lock control application does not have to be accurate at or above atmospheric pressure, thus does not need the convection enhancement that debilitates the pirani gauges at the critical cross-over pressure

range according to Hanson et al., as long as it is accurate in the cross-over range where pumping speed needs to be increased and in low enough pressure ranges for effective interior door control. Also, pirani gauges that are not convection-enhanced do not have the debilitating limitations in accuracy at the critical crossover pressure of 10 torr or slightly higher, as taught by Hanson et al., have better low end accuracy, e.g., at least down to $10^{-4}$ torr. Consequently, by using a pirani gauge that is accurate in at least the range of 100 torr to $10^{-4}$ torr in the absolute pressure sensing function for load locks according to this invention not only extends the low range absolute pressure measuring and interior door control capabilities over those taught by Hanson et al., but also eliminates the need for one of the three pressure gauges or switches that Hanson et al. taught were "necessary for proper monitoring and control of the loadlock cycle." *Id.*

In addition to eliminating one of the three pressure gauges or switches, as explained above, applicants also created a modular pressure transducer that not only senses both absolute and differential pressure and outputs, but also outputs both absolute pressure based control signals and differential pressure based control signals at desired absolute and differential pressure thresholds or values that are settable for actuating the interior door and exterior door as well as optional throttle valve control signals that are also settable and based on absolute pressure, by combining the pirani pressure sensor with its accuracy in at least the range of 100 torr to $10^{-4}$ torr and the differential pressure along with a control circuit in a housing and mounting them on a manifold that can be connected in one place to the load lock chamber. Prior to this invention, there was no pressure transducer that could sense both absolute and differential pressures and that could output control signals based on both absolute and differential pressures at settable absolute and differential pressure levels, and

there were no suggestions in any of the prior art references for such a unique combination absolute and differential pressure transducer.

The Stocker et al. patent merely shows a pressure sensor that combines the outputs of two different kinds of absolute pressure sensors to output one processed absolute pressure output that is more independent of the molecular type of the gas. Essentially, Stocker et al. use a pirani sensor, which produces outputs that are inversely proportional to the square root of molecular mass, and a quartz sensor, which produces outputs that are directly proportional to the square root of molecular mass, wherein both of such outputs are combined to produce a single output that is more independent of gas type. There is no suggestion in Stocker et al. of a transducer that outputs multiple control signals, let alone multiple control signals that are settable and based on both absolute and differential pressures. Stocker et al. is simply a structure with two different pressure sensors located in a common pressure volume with no other relevance to the method of the present invention. Again, the applicants do not claim to have invented either manifolds or pirani sensors. They did, however, invent a pressure transducer that can sense both absolute and differential pressure and output separate absolute pressure based control signals and differential pressure based control signals at settable absolute and differential pressure values for load lock operations.

Ikeda discloses an air conditioner compressor motor controller that keeps the motor at a constant speed when there is a certain pressure in the refrigerant system. It is an example of making a voltage set point for comparison with pressure measurements, but it is unrelated to load locks and certainly does not teach or suggest the adjustable combination absolute and differential pressure transducer method of this invention for controlling load lock operations.

Shie et al. is merely cumulative of the MKS Instruments Moducel Pirani Analog Transducer, Bulletin 9/99 series 325 cited earlier by applicants, which also shows a pirani gauge. Again, applicants do not claim to have invented pirani gauges. They do claim to have invented the unique modular and adjustable combination absolute and differential pressure transducer, only one component of which is a pirani sensor.

Summary:

In summary, the invention recited in applicant's amended claims 8 and 9 and new claims 10-18 is believed to be a novel and nonobvious advance over the three gauges that Hanson et al. asserted were necessary for proper monitoring and control of load locks, which is not shown or fairly suggested by any of the other prior art references cited. Therefore, the examiner is requested to reconsider the previous rejection of claims 8 and 9 in view of the amendments and to grant an early allowance. If any issues remain to be resolved, the examiner is requested to contact applicant's attorney at the telephone number listed below.

Respectfully Submitted,
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